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[54] **HIERARCHICAL TARGET INTERCEPT FUZZY CONTROLLER WITH FORBIDDEN ZONE**

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[*] Notice: This patent is subject to a terminal disclaimer.

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[52] **U.S. Cl.** **701/27**; 701/1; 244/3.13; 244/3.15

[58] **Field of Search** 701/1, 23, 27, 701/302; 395/3, 900, 905; 318/589; 244/3.1, 3.11, 3.13, 3.14, 3.15, 3.19

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,732,349	3/1988	Maurer	244/3.13
5,080,300	1/1992	Stubbs et al.	244/3.14
5,101,351	3/1992	Hattori	395/905
5,118,050	6/1992	Arnold et al.	244/3.19
5,319,556	6/1994	Bessacini	701/27
5,429,322	7/1995	Waymeyer	244/3.15
5,436,832	7/1995	Bessacini et al.	701/27
5,671,138	9/1997	Bessacini et al.	701/1
5,671,139	9/1997	Bessacini et al.	701/1
5,671,140	9/1997	Bessacini et al.	701/1

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[57] **ABSTRACT**

A target intercept guidance system for directing a steerable object, such as a torpedo with a guidance point. The guidance system is located at a launching vehicle and senses the bearings from the launching vehicle to a target and to the steerable object as it moves toward the target. Various error signals are then generated and classified into sensed linguistic variables using membership functions of corresponding sensed variable membership function sets based upon primary and secondary goals to become fuzzy inputs that produce fuzzy control output membership functions from a control output membership function set based upon logical manipulation of the fuzzy inputs. The control system performs this classification and selection according to sometimes competing goals of excluding the torpedo from a particular operating zone while guiding the torpedo in response to variations in a target bearing relative to the guidance point. The selected fuzzy control output membership functions are converted into an output having an appropriate form for control, subject to optional conditioning to prevent unwanted effects and assure good behavior for different tactical parameters.

34 Claims, 17 Drawing Sheets